Mercury Analysis Team Action Plan
2003

Introduction

The purpose of the Mercury Analysis Team is to develop an atmospheric mercury modeling system for Wisconsin and the Great Lakes region including a comprehensive analysis of the emission, transport, transformation, and deposition of mercury to land and water surfaces in the region. In October 2001, the WDNR received a two-year grant from USEPA's Great Lakes National Geographic Initiative to help fund this work.

Accomplishments during the first year of work include:

- revision of the emissions model to handle mercury emissions;
- quality assurance on available mercury inventories to identify missing sources;
- performance evaluation of available mercury chemistry deposition models;
- analysis of the sensitivity of available mercury chemistry deposition models to various input parameters;
- analysis of the quality and impact of available speciation profiles for mercury;
- analysis of the meteorological model, MM5, for simulating rainfall events.

The knowledge gained in completing this work allowed WDNR to participate in the larger community of mercury research. We provided technical analysis of modeling work completed by EPRI for the Wisconsin Utilities Association and a preliminary review of USEPA's Total Maximum Daily Load (TMDL) pilot project at Devil's Lake.

As a result of the analysis of available mercury chemistry deposition models we are partially funding the development of HGCAMx. This is a significant move forward. This model, available in the public domain, will include the best available mercury chemistry and is expected to have better model performance than current mercury models. Delivery is expected in the latter half of 2003.

In addition to supporting the development of and obtaining HGCAMx, the team has identified several goals for the next year. This plan describes in more detail the objectives we have including:

- Creating a 1999 inventory for mercury based on the 1999 National Emissions Inventory/NEI
- Develop modeling system for mercury for the 36km National Regional Planning Organization/RPO grid
- Conduct a test of mercury model sensitivity to meteorological input, specifically rainfall events
- Produce a peer-reviewed final report on our modeling project
- Analyze mercury monitoring needs in Wisconsin DNR
- Propose a field study of mercury flux and seek funding for that project.

The members of the Analysis Team are responsible for a variety of department functions including monitoring, inventory development, regional emissions modeling,

meteorological modeling, photochemical modeling, policy development, and rule development. Most team members have other responsibilities to the air program and are, therefore, unable to devote 100 percent of their time to mercury activities.

To continue to make progress, the team has adopted a strategic approach that includes:

- **LADCO** - Using our partnership with the PM/Haze modeling being done by the Midwest Regional Planning Organization/LADCO. Not only do several team members have a direct responsibility to support the LADCO PM modeling, but many of the issues being addressed by the PM modeling effort can be directly related to issues concerning mercury modeling. By "piggy-backing" on their effort, adopting the same main domain structure and episodes, and giving priority to completing projects we receive from LADCO we bolster our own resources and gain valuable information needed to complete mercury modeling.

- **Action Plan** - Developing an Action Plan with clear goals and assignments that are needed to move forward so that the sparse resources available have the biggest impact possible. As we complete the assignments and projects outlined here, we create a stronger base of knowledge and develop name recognition in the mercury community. These building blocks lay the foundation for future, more ambitious mercury work.

Plan Narrative

The team has identified the work goals that are essential for us to accomplish in the upcoming year. These goals can be categorized into the following groups:

- Inventory Development,
- Atmospheric Modeling,
- Monitoring,
- Support HGCAMx Development.

Challenges

In designing this Action Plan, members of the Team identified two general challenges that affect every area of our work.

Name Recognition - First, our team lacks name recognition in the field of atmospheric mercury. This creates a challenge when trying to obtain financial resources. To address this challenge, the team has identified three courses of action.

1. *Smaller Projects* - The team will design and conduct smaller projects. Reducing the scope or complexity will allow for project results to be used to screen the usefulness of a larger or more involved studies and help to direct the focus of additional work. Starting smaller will facilitate project management giving us the best circumstances for a successful project outcome. Reducing the amount of money needed to fund a project will also increase the chance of receiving funds.

2. *Peer Review* - The Team will seek external peer review for final modeling and/or research results. Peer review will be beneficial to our credibility and provide important feedback to improve our methods.

3. *Conferences/Education* - Team members will identify mercury related conferences and educational opportunities to help expand our knowledge of atmospheric mercury.

S. 105 Hours - Second, as team members shift more time to mercury from other programs, the number of hours billed to Air Management's 105 grant is potentially reduced. The bureau needs to bill the minimum number of hours required by the grant or risk losing funds. By using this Action Plan to develop realistic estimates of the time needed to complete Team projects, we can communicate to management the information they need to make work plan decisions that do not adversely affect other programs.

Inventory Development

LADCO is currently using a 1999 inventory for criteria pollutants. Although we will be able to use the inventory they develop for particulates and ozone, we need to develop an inventory of elemental, particulate and divalent mercury. Like the work being done at LADCO, we will use USEPA's 1999 National Emissions Inventory (NEI) as the basis of a 1999 inventory for mercury.

Task 1: 1999 NEI for HAPs - Obtain and consolidate the 1999 NEI for Hazardous Air Pollutants (HAPS) to create a mercury inventory for the modeling domain using the best available estimates.

Delivery of the 1999 NEI for HAPS has been delayed by USEPA several times. We will start with the 1999 NEI Version 3 Draft released in October 2002. Using the draft inventory will allow us to test our quality assurance processors, become more familiar with the data, and perform dry runs of the modeling process.

Task 2: Canadian Inventory - Acquire all available Canadian criteria and HAP inventories and convert them into National Inventory Format (NIF) Version 2.

Task 3: QA/QC - Implement the quality assurance/quality control (QA/QC) plan for the mercury emissions inventory drafted to use with the 1999 NEI using the following steps:

- Use EMS-2001 QA/QC processors that identify data that may not be acceptable for modeling purposes,
- Compare 1999 Great Lakes States (GLS) emission inventory project database with the 1999 GLS NEI data and resolve conflicts,
- Compare with 1998 Electric Power Research Institute's mercury database and resolve conflicts,
- Sum mercury emissions by Standard Industrial Classification (SIC) code and Source Classification Code (SCC),
- Document all changes made to the inventory.

Task 4: Missing Sources - Identify missing sources of mercury in the modeling domain using the 1999 NEI Version 3 Draft for Hazardous Air Pollutants (HAPs) and the 1999 NEI Version 2 Final for criteria pollutants.

The QA/QC plan describes a method for identifying missing sources based on identifying mercury related SCCs. The steps to implement this method include:

a) Identify SCCs associated with mercury emission processes
b) Where throughput is reported and emission factors are available, add mercury emissions to processes with SCC/AMS codes associated with mercury
c) Identify records that have mercury related SCC/AMS codes with too little information to estimate mercury emissions and place those records in separate tables
d) Identify possible missing sources that can be estimated domain-wide using a surrogate such as population or using emission factors for similar processes.

Task 5: Assessment of Mercury Sources - Use the Mercury Flow Diagram developed by Barr Engineering Company for WDNR and USEPA's Locating and Estimating (L&E) documents to assess sources of mercury.

Task 6: Inventory Sharing - Share our inventory with partners and other interested parties.

To facilitate sharing of data, the team will identify one person responsible to maintain our "official" inventory. That person will assign a version number to each inventory used for modeling purposes and fully document the sources of emission data and any changes made between updates. We will use a variety of methods to publicize the availability of our inventory including the peer review process, the Team website, and conferences.

Atmospheric Modeling

Current computer resources do not allow us to run a global domain and/or events longer than one year. However, elemental mercury can remain in the atmosphere

for well over a year and go around the world several times before being deposited. Because of this, we have chosen to look at the reaction of the mercury chemistry deposition model to a localized event (we have picked rainfall performance over a monitor site) and plan to continue to expand the domain as computing resources evolve.

Task 1: Run Models - Run our modeling system for mercury from the raw emissions files through the mercury chemistry deposition model using the following steps:

a) Set up a 36 km modeling domain covering the eastern US that is identical to the one being used by LADCO for PM/Haze modeling
b) Choose a modeling episode that coincides with an episode being used by LADCO for PM/Haze
c) Obtain all the ozone and particulate emission files for the appropriate episode and modeling domain from LADCO
d) Obtain all necessary processors from LADCO to convert model ready files to REMSAD format
e) Create model ready 1999 emissions files for mercury.

Task 2: Model Sensitivity - Analyze the sensitivity of the modeling process to improving the performance of rainfall estimates over specific Wisconsin MDN monitors using a 4 km nested grid.

Our modeling project is designed to investigate the contribution of the meteorological modeling to mercury chemistry deposition model performance. As we run smaller grids for met modeling, the need for more computer resources increases dramatically. Additionally, running a met model to optimize performance on rainfall can cause worse performance in the mercury chemistry deposition model. Therefore, we will work closely with others using MM5 for photochemical applications that also have interest in accurately predicting rainfall (e.g. forest service, LADCO). This analysis will require us to re-run the domain with a 12 km and 4 km nested grid using the following steps:

a) Create a 12km grid centered over Wisconsin and a 4km grid centered over at least one MDN monitor in Wisconsin
b) Create meteorological data using MM5 for the 12 km and 4 km grids
c) Analyze predicted mercury deposition at the MDN sites by evaluating the impact of using finer grids, analyzing how well rainfall is duplicated over the monitoring sites, and comparing differences in model performance for the MDN sites in the 4km grid.

Task 3: Change Models - Change from REMSAD to HGCAMX for mercury chemistry deposition modeling.

We are using a portion of our grant money to have mercury chemistry built in to CAMX. The model will likely be delivered in the latter half of 2003. We have familiarity using CAMX for PM modeling and expect a relatively easy transition. Until its delivery we will go forward with REMSAD to gain experience with the data flow.

Task 4: Emissions Model - Evaluate and update the emission model as necessary.

Initially, our emission modeling will be done using EMS-2001. As other options become available, we will evaluate those models to analyze their benefit.

Task 5: Draft Report - Write a draft report of modeling results from the 4 km nested grid run. This report will be used for peer review.

Task 6: Peer Review - Solicit peer review of draft modeling report. After internal review of modeling results, a list of possible reviewers will be compiled and sent an RFP to peer review our project or a request to provide a review gratis.

Task 7: Final Report – Incorporate or respond to comments received on draft modeling report. The final draft will be distributed to interested parties and submitted to USEPA for our grant.

Monitoring

Currently the air management program monitors mercury using five different methodologies. First, is wet deposition monitoring at 6 MDN (Mercury Deposition Network) sites located in the state. The newest site in Milwaukee (WI22) became operational in October 2002 and is partly funded by USGS. Statewide coverage is inadequate although there are currently no plans to increase the number of sites. Second, Wisconsin joined Michigan and Minnesota in 1999 to develop a mobile trailer, the Mercury Analysis Trailer (MAT), equipped with two Tekran mercury analyzers. Third, ambient mercury can be collected on adsorbent traps and analyzed by Method IO5 at the SLH (currently used for aircraft sampling). Fourth, mercury surveys can be conducted near a source using the hand-held Lumex monitor. Fifth, lichens are used to monitor mercury impacts near significant sources.

Task 1: Speciatied Data – Monitor for speciated emissions at major Wisconsin mercury sources such as the chlor-alkali facility located in Port Edwards.

The Tekran analyzers jointly operated with Michigan and Minnesota are limited to measuring total elemental mercury. Because reactive mercury may have more impact closer to the source, it is important to quantify the different species of mercury. The Team will work with Michigan and Minnesota to obtain funds to upgrade one of the Tekran analyzers to collect speciated mercury data. This will involve the purchase of a Model 1130 Mercury

Speciation Unit, a Model 1135 Particulate Mercury Unit, and support equipment at an estimated cost of $75,000.

Challenge – Obtaining the necessary funds for equipment, and developing and implementing a monitoring plan for speciated mercury will be difficult.

Task 2: MDN Sites – Assure adequate statewide coverage of mercury deposition data available in Wisconsin by increasing the number of MDN sites or moving existing sites.

Challenges: Monitoring personnel are at 100% capacity for workload. Some sampling methods take additional personnel time (i.e. event sampling) whereas others would take minimal time if overlapped with other monitoring duties. We will work with monitoring staff to take advantage of these overlaps where possible. We can also gain additional data by identifying and partnering with other parties doing mercury monitoring such as the University of Wisconsin and Tribal Governments in Wisconsin.

Task 3: Mercury Flux - Propose a field study of mercury flux and seek funding for the project.

Challenge - Traditional field studies of mercury flux are very expensive and difficult to fund. The large amount of funds needed makes it less attractive to be awarded a grant because most of the pool of money to distribute could be taken up by this one project alone. The Team will propose a much less costly field study to measure the vertical dry deposition flux of elemental gaseous mercury (Hg0) and reactive gaseous mercury (RGM) based on a conditional sampling method reported by Beverland et al for nitrogen flux measurements. This methodology would provide an important insight to the degree that Hg0 dry deposition contributes to the overall Hg mass loading to land and water surfaces.

Task 4: Northern MDN Sites – Analyze data trends for the three northern MDN sites in Wisconsin.

Challenge: Wisconsin currently does not have adequate statewide coverage of mercury wet deposition. Since it is very difficult to obtain funds to set up and operate additional MDN sites in the state, it may be feasible to relocate one of three Wisconsin MDN sites that are placed relatively close to each other in northern Wisconsin. The most compelling reason not to relocate one of the northern monitors is losing the history of data that provides information about trends. Therefore, an analysis is needed of the mercury data obtained from the three northern Wisconsin MDN sites. This analysis will answer the question if the three northern MDN sites provide unique trends data worth preserving or if one or more of the monitors "mirror" each other in trends and could more reasonably be moved without a loss of important information.

Task 5: Other Sources - Identify and monitor other sources of mercury using the Lumex and Tekran monitors.

Challenge – The current inventory may not be complete in regard to all sources of mercury emissions. Although the Lumex monitor does not give quantitative or speciated information about mercury emission sources, it is very valuable in identifying whether or not a given source is emitting mercury. The inventory developers and permit engineers can investigate sources and recommend further research for those sources that show promise based on Lumex readings. Once identified by the LUMEX, sources may be scheduled for more intensive studies. Short term monitoring studies (30 –day studies) using the Mercury Analysis Trailer will provide information on the local impacts of the source and the factors effecting the emissions/impacts. Factors may include time of day, temperature, wind direction and wind speed.

Support HGCAMx Development

Environ and Atmospheric Environmental Research (AER) have been contracted to develop a version of CAMx that includes Mercury (Hg) chemistry and deposition. As part of that contract, Wisconsin agreed to give support for inventory development, meteorological modeling, and assessment of model performance. Our obligations include:

- *1999 Inventory for Criteria Pollutants and Mercury* – Environ/AER will provide the 1998/1999 inventory that has been used in other modeling exercises. The team will compare this inventory to the 1999 NEI inventories being used by LADCO and Wisconsin. Wisconsin will provide model ready files to Environ/AER to use with HGCAMx.
- *Annual MM5 Output for Continental United States* – The team will provide 2002 annual meteorological outputs using MM5 for the meteorological modeling domain and modeling protocol being used in LADCO's PM/Haze modeling.
- *Model Performance Assessment* – The team will provide mercury chemistry deposition modeling runs needed to assess the performance of HGCAMx.

Workplan

Table 1: Proposed Activities and Time Estimates

Activity Category	Task	Cost	Total Hours 2003	Expected Completion Date	Individuals Involved
Inventory Development	1999 NEI for HAPS		240	Ongoing	Grant Hetherington (80) Orlando Cabrera-Rivera (40) Gwendolyn Judson (120)
	Develop Canadian inventory for criteria and HAPS		60	03/01/03	Gwendolyn Judson
	QA/QC of mercury inventory.		670	Ongoing	Grant Hetherington (275) Orlando Cabrera-Rivera (275) Gwendolyn Judson (120)
	Identify missing sources		1220	Ongoing	Grant Hetherington (456) Orlando Cabrera-Rivera (456) Grace Liu (288) David Grande (20)
	Assess sources of mercury		100	Ongoing	Grant Hetherington (50) Orlando Cabrera-Rivera (50)
	Share inventory with partners and other interested parties		20	Ongoing	Grant Hetherington (10) Orlando Cabrera-Rivera (10)
Atmospheric Modeling	Run mercury modeling system for 36km National RPO grid		610	07/15/03	Gwen Judson (260) Wusheng Ji (90) Mike Majewski (260)
	Analyze sensitivity of modeling system to meteorological inputs (12/4 km runs)		1630	09/01/03	Gwen Judson (260) Wusheng Ji (890) Mike Majewski (260)
	Change from REMSAD to HGCAMx mercury modeling		260	08/01/03	Mike Majewski
	Evaluate and update emissions model as necessary		120	Ongoing	Gwendolyn Judson
	Write draft report of modeling system with nested grids		240	09/01/03	Gwendolyn Judson (80) Grant Hetherington (40)

Activity Category	Task	Cost	Total Hours 2003	Expected Completion Date	Individuals Involved
					Mike Majewski (40) Wusheng Ji (80)
	Solicit peer review of draft modeling report	$0 - $15,000	40	09/15/03	Marty Burkholder
	Complete final report, incorporate comments, and distribute report to interested parties		80	11/01/03	Gwendolyn Judson
Monitoring	Monitor for speciated emissions (e.g. chlor-alkali plant)	$75,000	40+	Ongoing	Mark Allen Monitoring Staff
	Assure adequate statewide coverage of MDN sites	Each additional MDN site: • $5,000 one time cost • $18,000 annual cost	40	Ongoing	Mark Allen Monitoring Staff
	Propose and seek funding for a field study of mercury flux	The study will need funding of approx. $60,000.	60	1/31/03	Mark Allen (20) Bill Adamski (20) Marty Burkholder (20)
	Analyze data trends for three northern MDN sites in Wisconsin DNR		80	09/01/03	Bill Adamski
	Identify and monitor other sources of mercury		100	Ongoing	David Grande (80) Mark Allen (20)
Support HGCAMx Development	Provide 1999 inventories for criteria and mercury		240	04/01/03	Grant Hetherington (60) Orlando Cabrera-Rivera (60) Gwendolyn Judson (120)
	Provide annual MM5 output for National RPO grid		520	04/01/03	Wusheng Ji
	Provide modeling runs needed to assess performance of HGCAMx		260	06/01/03	Mike Majewski

Table 2: Work Plan Analysis

Name	Task	Time Code	Hours per Year	Total % FTE (1820 hrs/yr)	% FY 2002-2003	% FY 2003-2004
Bill Adamski	1. Propose funding for Hg flux field study	AMHG	80	9.45%	100	0
	2. Analysis of northern MDN sites	AMHG	80		70	30
	3. Attendance of Hg Analysis Team Meetings	AMHG	12		50	50
Mark Allen	1. MAT Improvements	AMGE-01	40	7.25%	50	50
	2. Mercury Monitoring Studies	AMGE-01	80		50	50
	3. Attendance of Hg Analysis Team Meetings	AMHG	12		50	50
Marty Burkholder	1. Solicit peer review of draft modeling report	AMHG	40	22.42%	0	100
	2. Propose and seek funding for a field study of mercury flux	AMHG	20		100	0
	3. Semi-Annual Reports to EPA (grant requirement)	AMHG	16		50	50
	4. Report Writing	AMHG	160		50	50
	5. Miscellaneous Administration (reviews, preparation, etc.)	AMHG	80		50	50
	6. Additional Grant Writing	AMHG	80		50	50
	7. Attendance of Hg Analysis Team Meetings	AMHG	12		50	50
Orlando Cabrera-Rivera	1. Provide preliminary inventory for HGCAMx evaluation	AMHG	60	49.62%	100	0
	2. 1999 NEI for HAPs	AMHG	40		60	40
	3. QA/QC	AMHG	275		40	60
	4. Missing Sources	AMHG	456		60	40
	5. Assessment of Mercury Sources	AMHG	50		75	25
	6. Inventory Sharing	AMHG	10		50	50
	7. Attendance of Hg Analysis Team Meetings	AMHG	12		50	50
David Grande	1. Missing Sources	AMHG	100	5.49%	50	50
Jon Heinrich	1. Preparation of team products	AMGE-17	34	4.40%	50	50
	2. Review of team products	AMGE-17	34		50	50
	3. Attendance of Hg Analysis Team Meetings	AMGE-17	12		50	50
Grant Hetherington	1. Provide preliminary inventory for HGCAMx evaluation	AMHG	60	58.41%	100	
	2. 1999 NEI for HAPs	AMHG	80		60	40
	3. QA/QC	AMHG	275		40	60
	4. Missing Sources	AMHG	456		60	40
	5. Assessment of Mercury Sources	AMHG	50		75	25

Name	Task	Time Code	Hours per Year	Total % FTE (1820 hrs/yr)	% FY 2002-2003	% FY 2003-2004
	6. Inventory Sharing	AMHG	10		50	50
	7. Write draft report on modeling system for inventory	AMHG	40		0	100
	8. Miscellaneous Administration (reviews, preparation, etc.)	AMHG	80		50	50
	9. Attendance of Hg Analysis Team Meetings	AMHG	12		50	50
Gwendolyn Judson	1. Translation of Canadian Inventories	AMHG (33%)	20	81.10%	100	0
		AMGE-06 (33%)	20		100	0
		AMGE-07 (33%)	20		100	0
	2. Provide model ready HG files for HGCAMx evaluation	AMHG	120		100	0
	3. Hg Emission Inventory QA/QC using EMS-2001	AMHG	120		70	30
	4. Hg Emission Inventory Support / Speciation	AMHG	120		50	50
	5. Hg Emission Modeling	AMHG	520		50	50
	6. Primary Author of Draft Report of modeling system	AMHG	80		0	100
	7. Write Final Report of modeling system incorporating peer review and comments	AMHG	80		0	100
	8. Distribution of Final Report	AMHG	20		0	100
	9. Write Hg Team Quarterly Reports	AMHG	80		50	50
	10. Hg Analysis Team Planning and Organization	AMHG	24		50	50
	11. Evaluate and update emission model as needed	AMHG	160		50	50
	12. Miscellaneous Administration (reviews, preparation, etc.)	AMHG	80		50	50
	13. Attendance of Hg Analysis Team Meetings	AMHG	12		50	50
Wusheng Ji	1. MM5 Model Set-up and Application for Mercury Modeling Episode (12/4 km run)	AMHG	20	87.47%	100	0
	2. MM5 Model Sensitivity Tests and Production Runs for Mercury Modeling Episode (12/4 km run)	AMHG	780		30	70
	3. Model Performance Evaluation (36 & 12/4 km run)	AMHG	100		50	50
	4. Interpolation of MM5 Output Files into Mercury Model File Format (36 & 12/4 km run)	AMHG	80		20	80
	5. Write Draft Report of modeling system for meteorological modeling	AMHG	80		0	100
	6. MM5 Annual Runs for Year 2002 (HGCAMx support)	AMHG	520		100	0

Name	Task	Time Code	Hours per Year	Total % FTE (1820 hrs/yr)	% FY 2002-2003	% FY 2003-2004
	7. Attendance of Hg Analysis Team Meetings	AMHG	12		50	50
Grace Liu	1. Missing Sources	AMHG	288	18.68%	25	75
	2. Miscellaneous Administration (reviews, preparation, etc.)	AMHG	40		50	50
	3. Attendance of Hg Analysis Team Meetings	AMHG	12		50	50
Mike Majewski	1. Run Mercury Modeling System for National 36km RPO Grid	AMHG	260	61.32%	50	50
	2. Analyze Sensitivity of Model to Meteorological Inputs	AMHG	260		50	50
	3. Change Modeling System from REMSAD to HGCAMx	AMHG	260		50	50
	4. Provide Modeling Runs Needed to Assess Performance of HGCAMx	AMHG	260		100	0
	5. Write Draft Report for modeling system for photochemical modeling	AMHG	40		0	100
	6. Miscellaneous Administration (reviews, preparation, etc.)	AMHG	24		50	50
	7. Attendance of Hg Analysis Team Meetings	AMHG	12		50	50